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(54) Annular air distributor for regenerative thermal oxidizers

(57) A regenerative thermal oxidizer in which contaminated air is first passed through a hot heat-exchange bed (25A) and into a communicating high temperature oxidation (combustion) chamber (26), and then through a relatively cool second heat exchange bed (25B). The apparatus includes a number of internally insulated, ceramic-filled heat recovery columns (A, B, C) topped by an internally insulated combustion chamber (26). Process air is directed into heat exchange media in one (A) of said columns via an annular distribution system, which allows for the uniform flow of gas in the apparatus, and greatly reduces the flushing volume. Oxidation is completed as the flow passes through the combustion chamber (26), where one or more burners (28) are located. From the combustion chamber, the air flows vertically downward through another column (B) containing heat exchange media (25B), thereby storing heat in the media for use in a subsequent inlet cycle when the flow control valves reverse. The resulting clean air is directed via an outlet valve (21B) through an outlet manifold (21) and released to atmosphere or is recirculated back to the oxidizer inlet (20). The flushing system allows for the removal of residual air laden with volatile organic compounds from the plenum and heat exchange media and is critical for maintaining high VOC destruction efficiency.

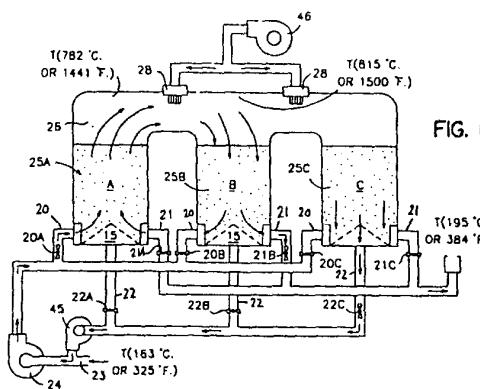


FIG. I

As VOC-laden gas enters the base of a regenerative column 10 that is on an inlet (gas heating) cycle, it is uniformly distributed about annular gap 18 and passes through the perforations 30 in the basket 16 until it fills the entire void volume within the column. This annular feed system causes a more even distribution of the air into the ceramic media than is otherwise achieved.

5 Although the process gas inlet to each column 10 is located near the base 14, there is the potential for an unused volume of heat exchange media at the bottom of the center of the bed. In order to eliminate this possibility, a perforated cone 15 (suitably made of stainless steel) is located at the base of the bed to fill this volume. The base of the cone 15 is about 30.5 cm (12") smaller in diameter than the inside diameter of the basket 16. The elevation of the cone is about 10 30° from the horizontal. The perforated cone 15 supports the heat exchange media 25, and preferably no heat exchange media is placed under the cone 15.

The perforations in the cone 15 are used in conjunction with the flushing of the annular air gap 18, valve plenum and heat exchange media 25 during a flushing cycle. Air is extracted from the annular air gap 18 around the basket 16, from the valve plenum and from within voids or interstices of the heat exchange media 25 via the perforated cone 15. To this end, a separate flushing manifold or ducting, containing a flushing fan 45 and a number of flow control valves, 15 connects the outlet of this fan 45 to the inlet of the oxidizer exhaust fan 24 and the inlet of this fan 45 to the flow control valves which are mounted on connections at the base of each valve plenum. Inside the valve plenum, a perforated pipe 40 joins the valve to the cone 15 such that when inlet valve 20A and outlet valve 21A are closed, the flushing valve 22A on that column will open, and VOC-laden air is drawn from the valve plenum, the annular gap 18 around the basket 16, and from within the cone 15, which allows air to be drawn from within the heat exchange media 25 and returned to the 20 inlet manifold and ducted into a regenerative column which is on an inlet cycle. The annular air distribution results in a decreased volume at the base of the heat exchange media, which in turn results in a smaller flushing volume. Those skilled in the art will be able to readily determine the number, geometry and size of the perforations on the pipe 40 and the cone 15 to allow for the optimal amount of air to be drawn from the various areas within the base of the column, which will depend upon the particular requirements of a given job. For example, 12 mm holes distributed to allow 20% 25 of the flushing air to be drawn from the annular gap 18, 60% of the flushing air to be drawn from the cone 15 and therefore from the heat exchange media 25, and 20% of the flushing air to be drawn from the valve plenum, have been found to be suitable. Those skilled in the art will further recognize that the relative amounts of flushing air to be drawn from these areas can be varied by varying the number, geometry and/or size of the perforations.

Since the fan 24 feeds the inlet of the oxidizer, the regenerative thermal oxidizer of the present invention utilizes a 30 "forced draft" system rather than the conventional "induced draft" system where the fan is located at the oxidizer exhaust. The forced draft system places the fan in the cooler inlet stream, resulting in a smaller fan. An additional benefit is that the forced draft fan acts as a "buffer" to reduce the effects of valve-induced pressure fluctuations on the upstream process.

The regenerative apparatus of the present invention can handle almost all size requirements, from about 113.3 normal m³/mn (4000 Standard Cubic Feet Per Minute) to about 2831 normal m³/mn (100,000 SCFM), by employing 35 additional columns. Applications requiring larger than 2831 normal m³/mn (100,000 SCFM) can be handled with multiple units.

By varying the amount of heat exchange media contained in the columns, thermal efficiencies (T.E.'s) of 85%, 90% or 95% can be obtained. For example, an 85% T.E. unit will have an approximate heat exchange media bed depth of 0.914 m (3 feet); a 90% T.E. unit will have a 1.83 m (6 foot) bed depth, and a 95% T.E. unit will have a 2.44 m (8 foot) 40 bed depth. Standard operating temperatures of 815°C (1500°F) are preferred, although design temperature of 982-1093°C (1800-2000°F) or higher can be accommodated.

Claims

45 1. A regenerative oxidizer system for purifying a gas, characterized by comprising:

- a plurality of regenerator columns (A, B, C) having a lower portion and an upper portion (6), each of said columns comprising heat exchange media (25A, 25B, 25C); gas inlet means (20); gas outlet means (21); and a basket (16), said basket having a perforated (at 30) portion having an outside diameter smaller than the inside diameter of said lower portion of said column so as to form an annular gap (18) between said perforated portion and said lower portion of said column;
- 50 a combustion chamber in communication with each of said plurality of regenerator columns;
- means (28) in said combustion chamber (26) for generating heat; and
- valve means (20A, 20B, 20C, 21A, 21B, 21C) for alternately directing said gas into the inlet means (20) of one of said plurality of columns in a first direction and through another of said plurality of columns in a second direction.

55 2. The regenerative oxidizer system of claim 1, characterized in that each of said plurality of columns further comprises a perforated cone (15) at the base thereof, said perforated cone supporting said heat exchange media and defining a volume below said perforated cone.

3. The regenerative oxidizer system of claim 2, characterized in that said volume below said perforated cone is devoid of heat exchange media.
4. The regenerative oxidizer of claim 2, characterized in that each of said plurality of columns further comprises gas purge means (22) comprising a perforated pipe (40) in communication with said volume below said perforated cone.
5. The regenerative oxidizer system of claim 1, characterized in that said means for generating heat comprises a burner (28).
10. 6. A process for combusting air laden with volatile organic compounds, characterized by comprising:
 - providing a plurality of regenerator columns (A, B, C) having a lower portion and an upper portion (6), each of said columns comprising heat exchange media (25A, 25B, 25C); gas inlet means (20); gas outlet means (21); and a basket (16), said basket having a perforated portion having an outside diameter smaller than the inside diameter of said lower portion of said column so as to form an annular gap (18) between said perforated portion and said lower portion of said column; a combustion chamber (26) in communication with each of said plurality of regenerator columns; means (28) in said combustion chamber for generating heat; and valve means (20A, 20B, 20C, 21A, 21B, 21C) for alternately directing said gas into the inlet means (20) of one (A) of said plurality of columns in a first direction and through another (B) of said plurality of columns in a second direction;
 20. feeding said air laden with volatile organic compounds into one (A) of said plurality of columns via said gas inlet means (20);
 - passing said air laden with volatile organic compounds through said annular gap (18) and into said heat exchange media (25A);
 - combusting said air laden with volatile organic compounds in said combustion chamber (26);
 - and exhausting said combusted air through a second (B) of said plurality of columns.
25. 7. The process of claim 6, characterised by further comprising providing a perforated cone (15) at the base of each of said plurality of columns, said perforated cone supporting said heat exchange media (25A, 25B, 25C) and defining a volume below said perforated cone; providing gas purge means (22) comprising a perforated pipe (40) in communication with said volume below said perforated cone; and flushing one (C) of said plurality of columns of air laden with volatile organic compounds by drawing air from said annular gap (18), from said volume below said perforated cone (15), from said valve means (20C, 21C), and from the gaps between said heat exchange media and recirculating said drawn air to another (A) of said plurality of regenerator columns.

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